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(54) Electroluminescence device

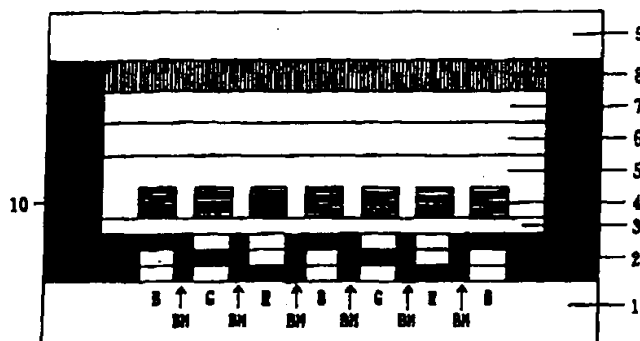
(57) An electroluminescence device comprising a transparent substrate having thereon at least:

a color filter layer;
a transparent electrode;
at least one organic compound layer including a light-emitting layer; and
a back electrode, in this order,
wherein said color filter layer has red, green and blue pixel patterns formed by a process which comprises:

applying a coating solution of a silver halide photographic layer onto said transparent substrate to form a photographic material;

patternwise exposing said silver halide color photographic material to light; and then
subjecting the exposed silver halide color photographic material to color development.

Fig. 1



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DescriptionFIELD OF THE INVENTION

5 The present invention relates to an electroluminescence device (hereinafter referred to as "EL"). More particularly, the present invention relates to an EL device having a color filter layer formed by using a silver halide color photographic material.

BACKGROUND OF THE INVENTION

10 An organic EL device has recently been noted as a display element substitute for LCD. Such a device is described, for example, in "Yuki EL Soshi Kaihatsu Senryaku (Strategy for Development of Organic EL Element)", 1992, Science Forum, "Flat Panel Display 1997", page 224, 1996, Nikkei BP, "NIKKEI ELECTRONICS 1996. 1. 29 (No. 654)", page 85, Nikkei BP, "Monthly Display '96 July", page 72, Technotimes. Further, JP-A-7-220871 (The term "JP-A" as used
15 herein means an "unexamined published Japanese patent application") discloses an organic electroluminescence device comprising at least a hole-transporting layer and an electron-transporting light-emitting layer having at least one dye dispersed in a polymer.

This organic EL device comprises a thin film layer which is made of an organic material laminate of a hole-transporting layer and an electron-transporting light-emitting layer and which is provided on a transparent substrate coated
20 with a transparent electrode made of indium-tin oxide (ITO) or the like, and a metal electrode made of magnesium/silver or the like provided on said thin film layer. When a voltage is applied to this organic EL device, it undergoes injection of holes from ITO and injection of electrons from the metal electrode made of magnesium/silver or the like. The electrons and holes are connected again to each other in the vicinity of the interface of the organic layers on the light-emitting layer side to excite neighboring dye, causing emission of white light. The white light is then taken out of the EL device
25 through a color filter layer provided to be interposed between the transparent electrode and the transparent substrate.

The advantage of such an organic EL device is that a high brightness and a drive at a low voltage and a low power can be realized with a simple layer structure by selecting a combination of light-emitting materials arbitrarily. However, the conventional organic EL device is disadvantageous in that the color filter layer which has heretofore been proposed to be incorporated therein is obtained by vacuum metallizing method, dyeing method, printing method, pigment dispersing method, electrodeposition method or resist electrodeposition transferring method, which requires a complicated
30 production step, tends to provide the resulting color filter with pinholes or marks and gives a poor yield and precision.

SUMMARY OF THE INVENTION

35 An object of the present invention is to provide an EL device provided having a color filter layer, which can be produced with little or no pinholes or marks at a high yield by a simple production process.

The present invention is also relates to a process for producing an EL device at a high yield with little or no pinholes or marks occurrence.

Other objects and effects of the present invention will be apparent from the following description.

40 The above described objects of the present invention have achieved by providing the followings.

(1) An electroluminescence device comprising a transparent substrate having thereon at least:

a color filter layer;

45 a transparent electrode;

at least one organic compound layer including a light-emitting layer; and

a back electrode in this order,

wherein said color filter layer has red, green and blue pixel patterns formed by a process which comprises:

50 applying a coating solution of a silver halide photographic layer onto said transparent substrate to form a photographic material;

patternwise exposing said silver halide color photographic material to light; and then

subjecting the exposed silver halide color photographic material to color development.

55 (2) The electroluminescence device according to the above (1), further comprising a water-impermeable protective layer provided interposed between said color filter layer and said transparent electrode.

(3) The electroluminescence device according to the above (1) or (2), wherein said organic compound layer comprises at least one layer containing a polymer compound.

(4) The electroluminescence device according to any one of the above (1) to (3), wherein said transparent substrate comprises a flexible plastic.

The present invention also relates to a process for producing an electroluminescence device comprising a transparent substrate having thereon at least: a color filter layer having red, green and blue pixel patterns; a transparent electrode; at least one organic layer; and a back electrode, which process comprises pixel pattern formation comprising:

applying a coating solution of a silver halide photographic layer onto a transparent substrate to form a photographic material;

patternwise exposing said silver halide color photographic material to light; and then

subjecting the exposed silver halide color photographic material to color development, to thereby form said pixel patterns on said transparent substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram illustrating a section of an EL device according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The color filter layer to be incorporated in EL device of the present invention is described in detail below.

In the present invention, a coating solution of a silver halide color photographic layer is applied onto a transparent substrate to form a silver halide light-sensitive material, from which a color filter layer is formed on the transparent substrate. The silver halide light-sensitive material preferably comprises at least three color light-sensitive layers each having a color sensitivity different from one another. The light-sensitive layers each comprises a color former (a coupler) incorporated therein so as to develop the respective color of blue, green and red (and, as needed, black) as a result of exposure and color development. A typical example of such an arrangement is an ordinary negative-working or positive-working color light-sensitive material comprising a yellow coupler incorporated in a blue-sensitive emulsion layer, a magenta coupler incorporated in a green-sensitive emulsion layer and a cyan coupler incorporated in a red-sensitive emulsion layer. Another typical example is a color light-sensitive material comprising a magenta coupler and a cyan coupler incorporated in a blue-sensitive emulsion layer, a yellow coupler and a cyan coupler incorporated in a green-sensitive emulsion layer and a yellow coupler and a magenta coupler incorporated in a red-sensitive emulsion layer.

The color sensitivity of the above-described silver halide photographic material is not limited to the combination of blue sensitivity, green sensitivity and red sensitivity. These color sensitivities may be combined with infrared sensitivity, ultraviolet sensitivity or yellow sensitivity. Further, a plurality of infrared-sensitive emulsion layers having different sensitivity wavelength ranges may be used. The order of application of silver halide emulsion layers having different color sensitivities may be appropriately selected. In addition to the above-described layer structure, a subbing layer, an interlayer, a bleachable yellow filter layer, a protective layer, an ultraviolet-absorbing layer, etc. may be further provided as needed.

For the details of the color light-sensitive material employable herein, reference can be made to JP-A-55-6342, JP-A-62-148952, JP-A-62-71950, JP-A-8-136722, JP-A-7-244212, and JP-A-8-22108.

Other components of the color light-sensitive layer for forming the color filter layer for use in the present invention can be selected from known materials. For the details of these materials, reference can be made to RD Nos. 17,643, 18,716 and 307,105. The location of the relevant descriptions are shown below.

Kind of additive		RD17643	RD18716	RD307105
1.	Chemical sensitizer	p. 23	p. 648 right column (RC)	p. 866
2.	Sensitivity increasing agent		ditto	
3.	Spectral sensitizer and supersensitizer	pp. 23-24	p. 648 RC-p. 649 RC	pp. 866-868
4.	Fluorescent brightening agent	p. 24	p. 647 RC	p. 868
5.	Antifoggant and stabilizer	pp. 24-25	p. 649 RC	pp. 868-870
6.	Light absorbent, filter dye, and ultraviolet absorbent	pp. 25-26	p. 649 RC-p. 650 left column (LC)	p. 873

(continued)

Kind of additive		RD17643	RD18716	RD307105
7.	Color coupler	p. 25 RC	p. 649 RC	pp. 871-872
8.	Dye image stabilizer	p.25	p. 650 LC	ditto
9.	Hardening agent	p. 26	p. 651 LC	pp. 874-875
10.	Binder	p. 26	p. 650 LC	pp. 873-874
11.	Plasticizer and lubricant	p. 27	p. 650 RC	p.876
12.	Coating aid and surface active agent	pp. 26-27	ditto	pp. 875-876
13.	Antistatic agent	p. 27	ditto	pp. 876-877

The material constituting the transparent substrate is preferably one having an excellent heat resistance. Examples of such a material include polyethylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, polystyrene, polycarbonate, polyether sulfone, cellulose acetate, polyarylate, soda glass, borosilicate glass and quartz. The surface of the substrate made of these materials may be subjected to primary coating treatment as needed. Further, the surface of the substrate may be subjected to glow discharge, corona discharge, ultraviolet (UV) irradiation or the like. The transparent substrate may be used in the form of tablet, sheet, film or the like. The thickness of the substrate may be appropriately selected depending on the intended purpose and on the kind of the material used. The thickness is, however, generally from 0.01 to 10 mm. For example, if the substrate is made of glass, its thickness is generally from 0.3 to 3 mm. In the present invention, the transparent substrate is particularly preferably a flexible plastic substrate preferably having a thickness of from 0.05 to 0.3 mm from the standpoint of producibility. In case where a plastic substrate is used, the substrate may have a gas barrier layer, a hard coat layer, etc. for inhibiting moisture and oxygen from permeating therethrough and for controlling the curl balance thereof.

In the present invention, the method for the application of a coating solution of a color light-sensitive layer onto the transparent substrate is not particularly limited. In the case of using a plastic substrate, a coating solution of a color light-sensitive layer is generally applied to a substrate which have been subjected to the above described primary coating treatment by a bar coating method, a spin coating method, a through coating method or a hopper coating method. In the case of using a glass substrate, the color light-sensitive layer may be formed by directly applying the coating solution onto the substrate by one of the above described coating methods. In addition, a color light-sensitive layer formed on a plastic substrate beforehand may be transferred to a glass substrate as described in JP-A-7-244212.

In the present invention, the above-described color photographic light-sensitive material is then subjected to exposure for forming blue, green and red pixel patterns and, as needed, a black stripe. The exposure method which can be used in the exposure step for use in the present invention may be any known method such as surface exposure process using a mask and scanning exposure process. Examples of the scanning method includes line (slit) scanning methods and point scanning methods by laser exposure. Examples of the light source for use herein include tungsten lamp, halogen lamp, fluorescent tube (e.g., three-wavelength type fluorescent tube), xenon lamp, mercury vapor lamp, laser and light-emitting diode. Particularly preferred among these light sources are halogen lamp, fluorescent tube and laser.

Thereafter, the thus exposed color light-sensitive material is subjected to an ordinary color development as described in Research Disclosure (RD) Nos. 17643 (pp. 28 - 29) and 18716 (left column to right column on page 651) to form a microcolor filter.

The color development process normally comprises color development step, desilvering step, rinsing step and drying step. In the desilvering step, a blix step using a blix solution may be effected instead of bleaching step using a bleaching solution and fixing step using a fixing solution. Alternatively, the bleaching step, the fixing step and the blix step may be combined in an arbitrary order. A stabilizing step may be effected instead of or after rinsing step. Further, a monobath processing step using a monobath developing, bleaching and fixing solution for effecting color development, bleaching and fixing in one bath may be effected. In combination with these processing steps, a pre-hardening step, a neutralizing step therefor, a stop and fixing step, a post-hardening step, an adjusting step, an intensifying step, etc. may be effected. In these steps, the color development step may be replaced by a so-called activator processing step.

As described in JP-A-7-159610, an internal latent image type auto positive emulsion may be subjected to color development and desilvering with a nucleating agent and a light fogging agent in combination.

A developing apparatus for use in the present invention may be one for use in ordinary photographic processing if the transparent substrate is flexible. In the case of hard substrate such as glass, a developing machine for glass dry plate or a developing apparatus as described in JP-A-7-56015 may be used.

The color filter thus prepared is preferably coated with a water-impermeable protective layer (overcoat layer) as on

outermost layer of the color filter. The water-impermeable protective layer is generally heat-resistant and water-resistant and has a high specific electric resistivity. Preferred materials of the protective layer include the resins described in U.S. Patents 4,698,295 and 4,668,601, EP-179,636A, EP-556,810A, JP-A-3-163416, JP-A-3-188153, JP-A-5-78443, JP-A-1-276101, JP-A-60-216307, JP-A-63-218771 and Japanese Patent Application Nos. 8-238154 and 8-276027.

On the color filter, there may be preferably provided a single or multicomponent metal oxide glass layer (which functions as a water-impermeable protective layer) formed by a process which comprises: applying a reaction product obtained by the hydrolysis and dehydrocondensation of a hydrolyzable organic metal compound in a reaction solution made of water and an organic solvent with a halogen ion as a catalyst in the presence of boron ion while adjusting the pH value thereof to a range of from 4.5 to 5.0; and then vitrifying the reaction product at a temperature of not higher than 200°C. For the details of this technique, reference can be made to Japanese Patent Application No. 8-235621.

In the present invention, the method for the application of the composition forming the above-described protective layer is not particularly limited. Various methods such as spray coating method, bar coating method and spin coating method may be used.

On the color filter or protective layer thus prepared, further formed is a transparent electrode which acts as an anode by an evaporation method such as vacuum metallizing and sputtering. Examples of the transparent electrode include tin oxide (NESA), zinc oxide, indium oxide/tin oxide composite compound (ITO), indium oxide/zinc oxide compound, tin oxide/antimony oxide compound, gallium oxide/zinc oxide compound and electrically-conductive polymers such as polypyrrole, polyaniline and polymethylthiophene.

On the transparent electrode thus formed, at least one organic compound layer containing a light-emitting layer is further provided. On the organic compound layer, a back electrode (cathode) is further provided. Specific examples of the laminate structure include anode/hole-transporting layer/light-emitting layer/cathode, anode/light-emitting layer/electron-transporting layer/cathode, anode/hole-transporting layer/light-emitting layer/electron-transporting layer/cathode, and anode/light-emitting layer/cathode. However, the present invention is not limited to these structures. For example, these structures may have a plurality of light-emitting layers, hole-transporting layers and electron-transporting layers. Further, a plurality of light-emitting layers may be combined to form a white light-emitting layer. Furthermore, a hole-injecting layer or an electron-injecting layer may be provided. Moreover, a layer structure such as hole-transporting layer/light-emitting layer, light-emitting layer/electron-transporting layer and hole-transporting layer/light-emitting layer/electron-transporting layer may be repeatedly laminated. A particularly preferred light-emitting layer for use in the present invention is one disclosed in JP-A-7-220871 and JP-A-7-90260, which is provided with at least a hole-transporting layer and an electron-transporting light-emitting layer or with at least an electron-transporting layer and a hole-transporting light-emitting layer, in which the light-emitting layer has at least one light-emitting material dispersed in a polymer to form a white light-emitting layer. In addition, light-emitting polymer materials are preferably used. Examples of the light-emitting polymer material include polymers having a low molecular weight dye and tetraphenyldiamine or triphenylamine incorporated in their main or side chain, as well as π conjugated system polymers such as poly-p-phenylenevinylene derivatives.

These white light-emitting layers each preferably comprise a plurality of light-emitting materials molecularly dispersed in a polymer compound so that the resulting emission spectra widely covers the visible light range. Further, the electron-transporting light-emitting layer or hole-transporting light-emitting layer preferably comprises a light-emitting material molecularly dispersed in a polymer compound which is capable of transporting carrier by itself, or comprises a low molecular weight carrier-transporting agent and a light-emitting material molecularly dispersed in a polymer compound which is incapable of transporting carrier.

Moreover, in electron-transporting light-emitting layer and a hole-transporting light-emitting layer each comprising a light-emitting material having emission spectra different from each other dispersed in the respective layer may be laminated to form a white light-emitting layer as a whole.

The light-emitting material for use in the present invention is not particularly limited, and any materials which emits fluorescence when excited may be used. Examples thereof include oxinoid compounds, perylene compounds, coumarin compounds, azacoumarin compounds, oxazole compounds, oxadiazole compound, perinone compounds, pyrrolidopyrrole compounds, naphthalene compounds, anthracene compounds, fluorene compounds, fluoranthene compounds, tetracene compounds, pyrene compounds, coronene compounds, quinolone compounds, azaquinolone compounds, pyrazoline derivatives, pyrazolone derivatives, rhodamine compounds, chrysene compounds, phenanthrene compounds, cyclopentadiene compounds, stilbene compounds, diphenylquinone compounds, styryl compounds, distyrylbenzene compounds, butadiene compounds, dicyanomethylenepyran compounds, dicyanomethylenethiopyran compounds, fluorescein compounds, pyrilium compounds, thiapyrilium compounds, selenapyrilium compounds, telluropyrilium compounds, aromatic aradiene compounds, oligaphenylene compounds, xanthene compounds, thioxanthene compounds, cyanine compounds, acridine compounds, acridone compounds, quinoline compounds, metal complexes of 8-hydroxyquinoline compounds, benzoquinolinol beryllium complex, metal complexes of 2,2'-bipyridine compounds, complexes of Schiff salt with a group III metal, metal complexes of oxadiazole compounds and rare earth metal complexes. Such a light-emitting material may be molecularly dispersed in a carrier-

transporting polymer compound. Alternatively, a low molecular weight carrier-transporting material and a light-emitting material may be molecularly dispersed in a polymer compound incapable of transporting carrier.

The term "electron-transporting polymer compound" as used herein means a polymer compound containing an electron accepting group in its side or main chain. The term "hole-transporting polymer compound" as used herein means a polymer compound containing an electron donative group in its side or main chain. The term "polymer compound incapable of transporting carrier" as used herein means an electrically inert polymer compound such as polymethyl methacrylate, polymethyl acrylate, polystyrene and polycarbonate. The "low molecular weight carrier-transporting material" to be used when there are no carrier transporting properties means an electron-transporting (electron-accepting) or hole-transporting (electron donative) low molecular weight material.

Examples of the electron-transporting compound for use in the present invention include oxadiazole derivatives, triazole derivatives, triazine derivatives, nitro-substituted fluorenone derivatives, thiopyran dioxide derivatives, diphenylquinone derivatives, perylenetetracarboxyl derivatives, anthraquinodimethane derivatives, fluorenilidenemethane derivatives, anthrone derivatives, perinone derivatives, oxine derivatives and quinoline complex derivatives.

Examples of the hole-transporting compound for use in the present invention include polymer compounds such as poly-N-vinylcarbazole, polyphenylene vinylene derivatives, polyphenylene, polythiophene, polymethylphenylsilane and polyaniline, triazole derivatives, oxadiazole derivatives, imidazole derivatives, polyarylethane derivatives, pyrazoline derivatives, pyrazolone derivatives, phenylenediamine derivatives, arylamine derivatives, amino-substituted chalcone derivatives, oxazole derivatives, carbazole derivatives, styrylanthracene derivatives, fluorenone derivatives, hydrazone derivatives, stilbene derivatives, porphyrin derivatives such as phthalocyanine, aromatic tertiary amine and styrylamine compounds, butadiene compound, benzidine derivatives, polystyrene derivatives, triphenylmethane derivatives, tetraphenylbenzene derivatives and starburst polyamine derivatives.

Examples of the at least one organic compound layer containing a white light-emitting layer include one disclosed in JP-A-7-220871, which comprises a hole-transporting layer comprising a polyvinylcarbazole (PVK) having high hole-transporting ability and a light-emitting layer comprising an electron-transporting oxadiazole derivative (PBD) and a fluorescent dye, as a emission center, such as tetraphenylbutadiene (TPB), coumarine 6, DCM1 and Nile red, each incorporated in a polymethyl methacrylate (PMMA) in a small amount. These fluorescent dyes emit blue light (TPB), green light (coumarine 6), yellow light (DCM1) or red light (Nile red). When these fluorescent dyes emit concurrently, the resulting light becomes white light. For the details of the principle of the light emission, reference can be made to JP-A-7-220871.

Referring to the structure of the above-described example, an electron-transporting, white light-emitting layer is provided on a hole-transporting layer which has been provided in contact with a transparent electrode (anode) made of ITO or the like.

For retaining the adhesion between the anode and the hole-transporting layer, an anode interfacial layer having a thickness of about from 0.01 to 30 nm may be provided. Examples of a compound for use in the anode interfacial layer include condensed polycyclic dyes such as spiro compounds, azo compounds, quinone compounds, indigo compounds, diphenylmethane compounds, quinacridone compounds, polymethine compounds, acridine compounds and porphyrin compounds, and low molecular weight p-type semiconductor.

The incorporation of a polymer compound in the hole-transporting layer, electron-transporting layer and light-emitting layer allows the formation of these layers by application in the form of solution. Therefore, together with the application of a color light-sensitive layer and the use of a transparent plastic substrate for the formation of a color filter, the arrangement of the present invention allows an efficient production of EL device at a low cost. This is a feature of the present application. Additionally, the organic compound layer containing a polymer compound can be formed according to a known coating method such as dipping method, spin coating method, casting method, bar coating method, roll coating method, and the like. Further, simultaneous multi-layer coating of these layers becomes possible by appropriately selecting solvents for the respective layers.

On the above-described electron-transporting layer, a metal electrode is provided as a back electrode (cathode). Examples of the material for use in the back electrode include metals having a small work function such as magnesium, calcium, sodium, potassium, titanium, indium, yttrium, lithium, gadolinium, ytterbium, ruthenium, manganese, aluminum, silver, tin and lead, and alloys thereof. Further, a thin layer made of aluminum oxide or lithium fluoride having a thickness of about 0.01 to 30 nm may be interposed between the electron-transporting layer and the metal electrode. The back electrode may be an electrically-conductive coating layer (paste) as described in JP-A-7-85974. On the surface of the back electrode, there may be formed a protective layer (sealing layer) for blocking moisture. For the details of the protective layer for this purpose, reference can be made to JP-A-7-85974.

By forming the above-described transparent electrode and metal electrode crosswise to each other as described in JP-A-7-220871, and by applying a d.c. (which may have a.c. component, as needed) or a.c. voltage (normally, a pulse voltage of from 2 to 30 volt) across the two opposing electrodes, the point of intersection formed by the two opposing electrodes is rendered capable of emitting light, making it possible to cause the light-emitting layer to emit light. A simple matrix driving full-color display can be obtained by combining the above-described laminate with the above-

described color filter layer (Fig. 1).

For driving the EL device of the present invention, the methods disclosed in JP-A-2-148687, JP-A-6-301355, JP-A-5-29080, JP-A-7-134558, JP-A-8-234683 and JP-A-8-241047 can be used.

Preferably, the back electrode closely contacts with a substrate. The substrate for use herein does not necessarily need to be transparent but may be light-screening. Although the material of this substrate may be appropriately selected from the group consisting of plastic, glass and metal, moisture and air impermeable materials are preferred. Desiccants or water repellent fluorine-based inert liquid may be interposed between the back electrode and the above-mentioned substrate.

The lamination of the above-mentioned substrate with the back electrode for sealing may be conducted using an adhesive after the formation of the back electrode on the organic compound layer such is the above-described electron-transporting layer by vacuum metallizing method, sputtering method, printing method or the like. Alternatively, the back electrode may be first formed on the substrate by vacuum metallizing method, sputtering method, printing method or the like, followed by the lamination with the organic compound layer to thereby seal.

One embodiment of the EL device according to the present invention is shown in Fig. 1 in the form of a diagram illustration, but the present invention is not limited to this constitution. Fig. 1 is a sectional view of an EL device of the present invention. This device has an arrangement such that a color filter layer 2, a protective layer 3, a transparent electrode (anode) 4, a hole-transporting layer 5, a white light-emitting layer 6, an electron-transporting layer 7 and a back electrode (cathode) 8 according to the present invention are provided between a transparent substrate 1 and a substrate 9 and sealed with sealants 10.

The present invention will be described in greater detail below with reference to the following Examples, but the invention should not be construed as being limited thereto.

EXAMPLE 1

A transparent polyether sulfone substrate (thickness: 150 μm) having a gas barrier layer and a hard coat layer was subjected to glow discharge treatment and coated with two layers (thickness: 0.1 μm), i.e., SBR latex layer and gelatin layer to facilitate the adhesion with a photographic emulsion layer. Onto the substrate, color light-sensitive layers were coated by a simultaneous multi-layer coating process to prepare a color photographic light-sensitive material (2A). The layer constitution of the color photographic light-sensitive material (2A) and details of the respective layers are shown in (A) below.

The photographic light-sensitive material thus prepared was stripwise exposed to white light through a mask filter, and then subjected to color development, desilvering and rinsing, to thereby prepare a color filter having 0.4 mm-wide R, G and B pixels and a 0.1 mm-wide black matrix. Details of the processing step used for the light-sensitive material (2A) are shown in (B) below.

The surface of the color filter was coated with a UV-curing type acrylate resin, which was then cured to form a protective layer thereon.

(A) Layer Constitution

The components of the respective layers and the coating amount thereof (unit: g/m^2) are shown below. With respect to the silver halide, the coating amount is calculated in terms of silver.

First Layer (antihalation layer):

Gelatin	0.70
Antihalation dye (fine particle dispersion)	0.17
Carboxymethyl cellulose	0.05
Surface active agent (Cpd-16)	0.03
Hardener (H-1)	0.12

Second Layer (infrared-sensitive layer):

5	Silver halide emulsion spectrally sensitized by Infrared Sensitizing Dye (ExS-6) (AgBr ₃₀ Cl ₇₀ ; average grain size: 0.2 μ m)	0.28
	Stabilizer (Cpd-12)	0.005
	Gelatin	0.57
10	Cyan Coupler (ExC-2)	0.10
	Yellow Coupler (ExY-1)	0.35
	Magenta Coupler (ExM-1)	0.14
15	Discoloration Inhibitor (Cpd-3)	0.05
	Discoloration Inhibitor (Cpd-4)	0.005
	Discoloration Inhibitor (Cpd-5)	0.02
	High Boiling Point Solvent (Solv-1)	0.42
20	High Boiling Point Solvent (Solv-2)	0.10
	Stain Inhibitor (Cpd-13)	0.01
	Polymer (Cpd-14)	0.01

Third Layer (interlayer):

30	Gelatin	0.38
	Color Mixing Inhibitor (Cpd-2)	0.02
	Color Mixing Inhibitor (Cpd-10)	0.09
35	High Boiling Point Solvent (Solv-1)	0.03
	High Boiling Point Solvent (Solv-3)	0.01
	Ultraviolet Absorbent (Cpd-8)	0.02
	Ultraviolet Absorbent (Cpd-7)	0.02
40	Ultraviolet Absorbent (Cpd-6)	0.01
	Ultraviolet Absorbent (Cpd-9)	0.02
	Stain Inhibitor (Cpd-11)	0.04

Fourth Layer (red-sensitive Layer):

50	Silver halide emulsion spectrally sensitized by Red Sensitizing Dyes (ExS-4 and ExS-5) (AgCl; average grain size: 0.18 μ m)	0.31
	Gelatin	0.77
	Yellow Coupler (ExY-1)	0.53
55	Magenta Coupler (ExM-2)	0.29
	Discoloration Inhibitor (Cpd-3)	0.06

(continued)

	Discoloration Inhibitor (Cpd-4)	0.005
	Discoloration Inhibitor (Cpd-5)	0.01
5	High Boiling Point Solvent (Solv-1)	0.48
	High Boiling Point Solvent (Solv-2)	0.12
	Polymer (Cpd-14)	0.03

10 Fifth Layer (interlayer):

15	Gelatin	0.38
	Color Mixing Inhibitor (Cpd-2)	0.02
	Color Mixing Inhibitor (Cpd-10)	0.09
	High Boiling Point Solvent (Solv-1)	0.03
20	High Boiling Point Solvent (Solv-3)	0.01
	Ultraviolet Absorbent (Cpd-8)	0.02
	Ultraviolet Absorbent (Cpd-7)	0.02
25	Ultraviolet Absorbent (Cpd-6)	0.01
	Ultraviolet Absorbent (Cpd-9)	0.02
	Stain Inhibitor (Cpd-11)	0.04
30	Irradiation Preventive Dye (Dye-1)	0.005
	Irradiation Preventive Dye (Dye-2)	0.02

35 Sixth Layer (green-sensitive layer):

40	Silver halide emulsion spectrally sensitized by Green Sensitizing Dye (ExS-3) (AgCl; average grain size: 0.18 μm)	0.43
	Gelatin	1.09
	Cyan Coupler (ExC-1)	0.33
	Yellow Coupler (ExY-1)	0.43
45	Discoloration Inhibitor (Cpd-5)	0.01
	Stain Inhibitor (Cpd-13)	0.01
	High Boiling Point Solvent (Solv-1)	0.08
	High Boiling Point Solvent (Solv-2)	0.11
50	Polymer (Cpd-14)	0.03

Seventh Layer (interlayer):

5	Gelatin	0.38
	Color Mixing Inhibitor (Cpd-2)	0.02
	Color Mixing Inhibitor (Cpd-10)	0.09
10	High Boiling Point Solvent (Solv-1)	0.03
	High Boiling Point Solvent (Solv-3)	0.01
	Ultraviolet Absorbent (Cpd-8)	0.02
	Ultraviolet Absorbent (Cpd-7)	0.02
15	Ultraviolet Absorbent (Cpd-6)	0.01
	Ultraviolet Absorbent (Cpd-9)	0.02
	Stain Inhibitor (Cpd-11)	0.04
20	Yellow Dye (YF-1)	0.17

Eighth Layer (blue-sensitive layer):

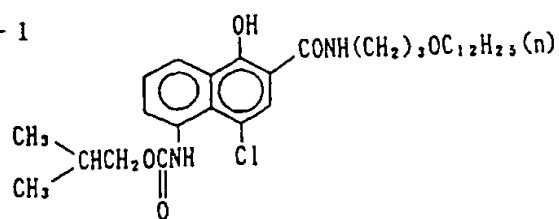
25	Silver halide emulsion spectrally sensitized by Blue Sensitizing Dyes (ExS-1 and ExS-2) ($\text{AgBr}_{30}\text{Cl}_{70}$; average grain size: 0.35 μm)	0.33
	Gelatin	1.00
30	Cyan Coupler (ExC-2)	0.57
	Ultraviolet Absorbent (Cpd-6)	0.03
	Ultraviolet Absorbent (Cpd-7)	0.08
35	High Boiling Point Solvent (Solv-1)	0.23

Ninth Layer (protective layer):

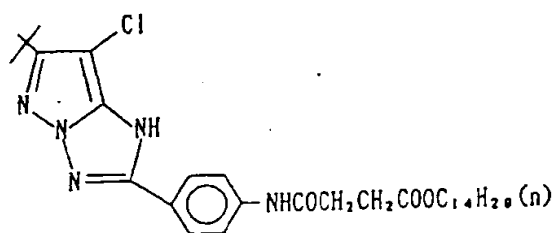
40	Gelatin (acid-processed)	0.51
	Antistatic agent (Cpd-1)	0.03
45	Snowtex-O (produced by Nissan Kagaku Kogyo KK)	0.16

In each layer, sodium dodecylbenzenesulfonate as an emulsification dispersion aid, ethyl acetate as an auxiliary solvent, Surface Active Agent (Cpd-17) as a coating aid and potassium polystyrenesulfonate as a thickening agent were used.

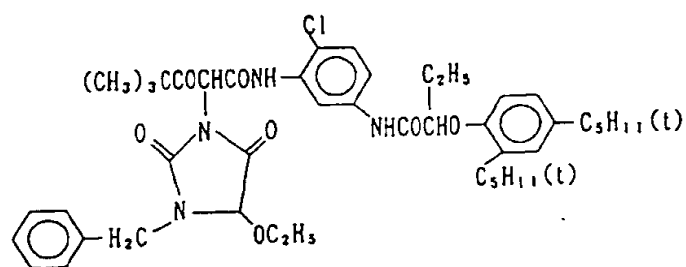
Ex C - 1



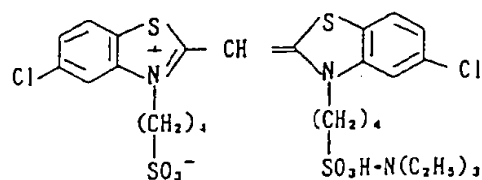
Ex M - 1



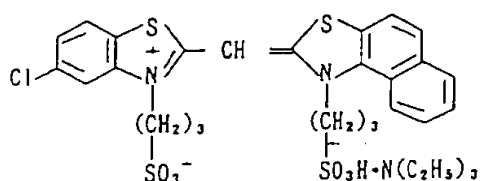
Ex Y - 1



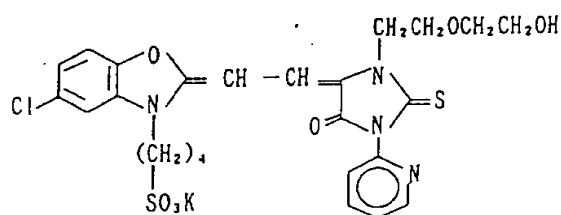
Ex S - 1



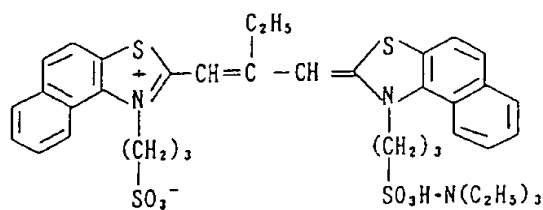
Ex S - 2



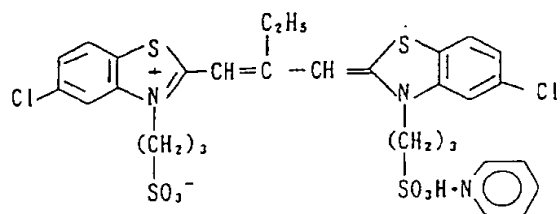
Ex S - 3



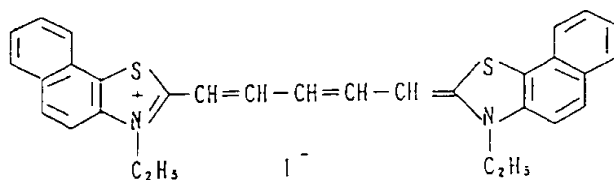
Ex S - 4



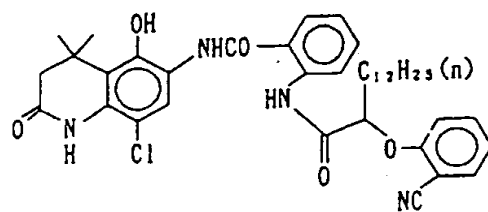
Ex S - 5



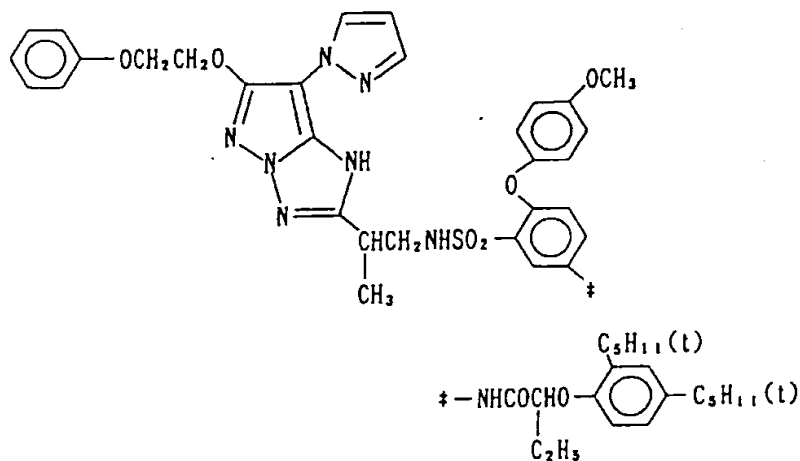
Ex S - 6



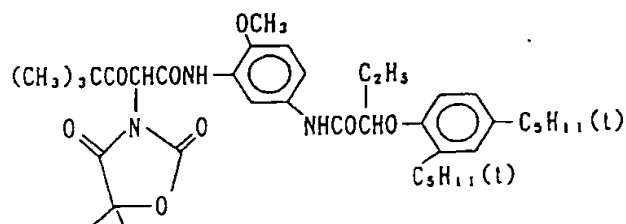
Ex C - 2

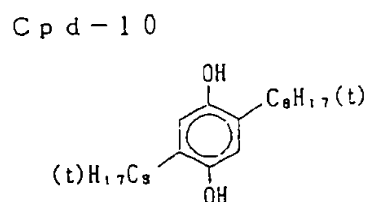
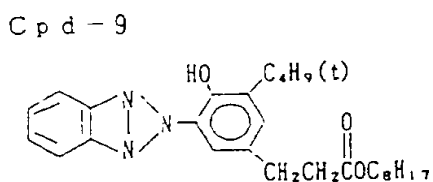
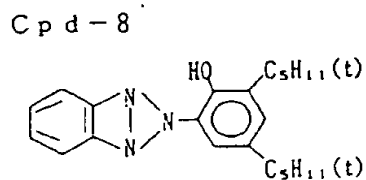
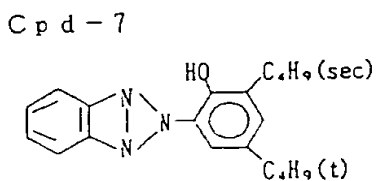
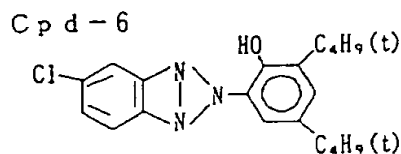
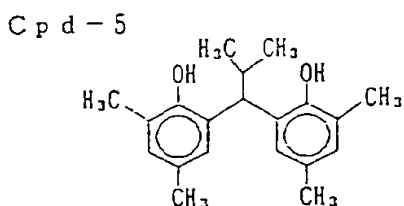
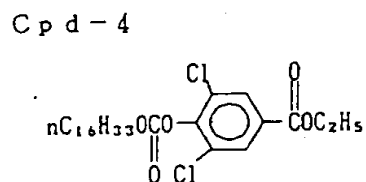
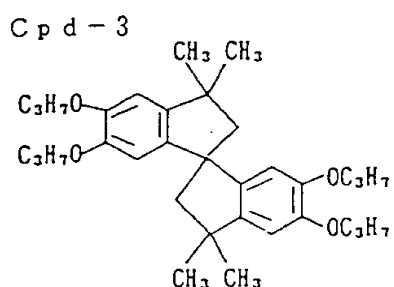
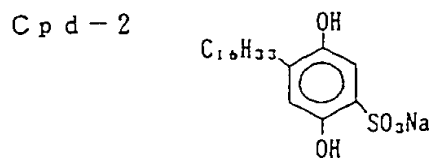
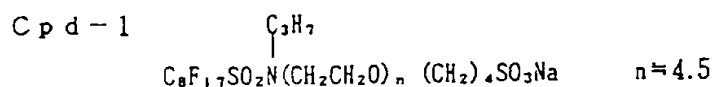


Ex M - 2

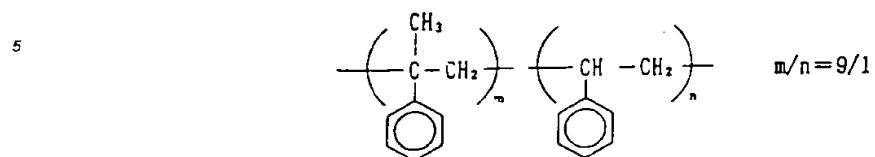


Ex Y - 2

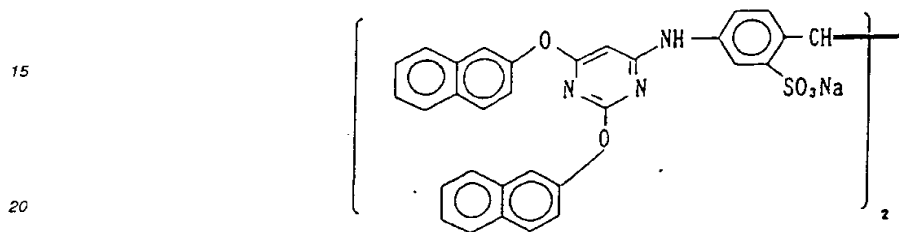




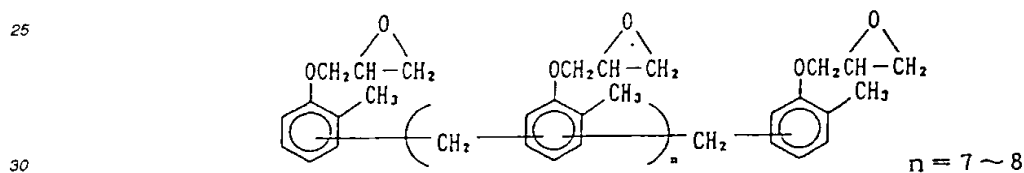
Cp d - 1 1



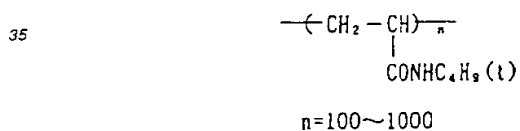
Cp d - 1 2



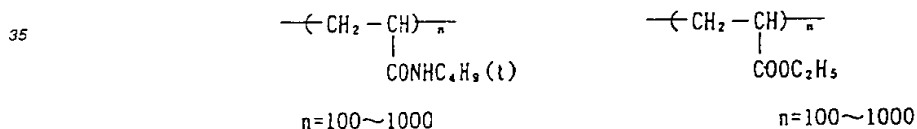
Cp d - 1 3



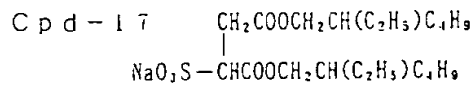
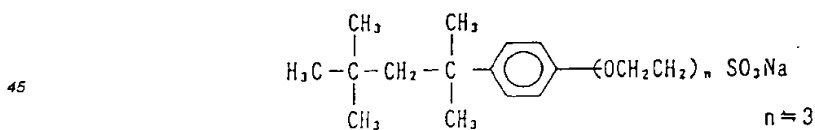
Cp d - 1 4



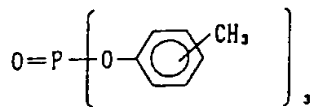
Cp d - 1 5



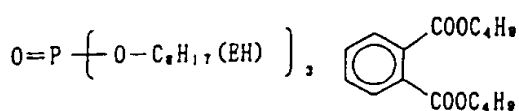
Cp d - 1 6



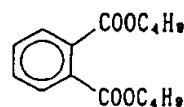
Solv-1



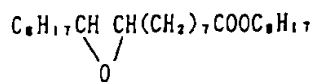
Solv-2



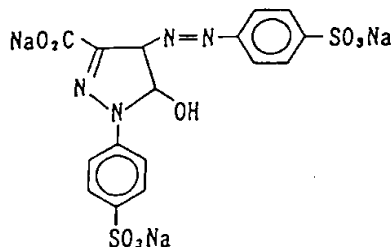
Solv-3



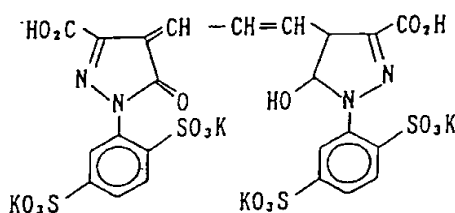
Solv-4



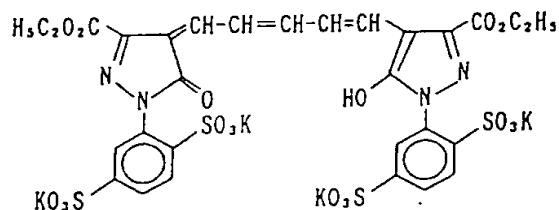
YF-1



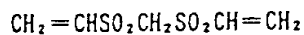
Dye-1



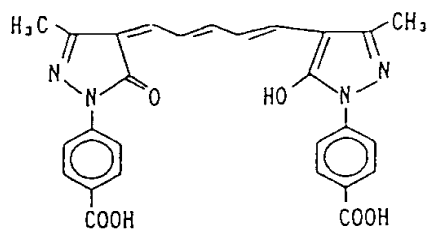
Dye-2



H-1



Antihalation dye



(B) Processing Step

Processing Step	Temperature (°C)	Time
Color development	38	80 sec.
Bleach-fixing	38	90 sec.
Water washing-1	35	40 sec.
After-hardening	38	3 min.
Water washing-2	35	2 min.
Drying	60	2 min.

Each processing solution had the following composition.

Color Developer:

Water	800 ml
D-Sorbitol	0.15 g
Sodium naphthalenesulfonate - formalin condensate	0.15 g
Pentasodium nitrotris(methylenephosphonate)	1.8 g
Diethylenetriaminepentaacetic acid	0.5 g
1-Hydroxyethylidene-1,1-diphosphonic acid	0.15 g
Diethylene glycol	12.0 ml
Benzyl alcohol	13.5 ml
Potassium chloride	6.5 g
Potassium bromide	0.1 g
Potassium carbonate	30.0 g
Sodium sulfite	2.4 g
Disodium N,N-bis(sulfonatoethyl)-hydroxylamine	8.0 g
Triethanolamine	6.0 g
Benzotriazole	0.01 g
N-Ethyl-N-(β -methanesulfonamidoethyl)-3-methyl-4-aminoaniline 3/2 sulfate monohydrate	6.0 g
Water to make	1 l
pH (25°C)	10.6

Bleach-Fixing Solution:

Water	600 ml
Ammonium thiosulfate (750 g/l)	160 ml

(continued)

Ammonium sulfite	40.0 g
Ammonium ethylenediaminetetraacetato ferrate	55.0 g
Ethylenediaminetetraacetic acid	5.0 g
Ammonium nitrate	10.0 g
Ammonium bromide	25.0 g
Water to make	1 l
pH (25°C)	6.0

Washing Water:

Deionized water having an electric conductivity of 5 μ S or less

After-Hardening Solution:

Aqueous solution containing 10% of glutaraldehyde.

Then, an ITO layer having a thickness of 0.1 μ m was formed on the protective layer by a sputtering method. The ITO layer was patterned by a photoresist method in conformity with the stripe pattern on the color filter.

Onto the ITO electrode, a coating solution obtained by dissolving 2 g of PVK in 100 ml of dichloromethane, and then dissolving 30% by weight of PBD, 3 mol% of TPB, 0.04 mol% of coumarine-6, 0.02 mol% of DCM1 and 0.015 mol% of Nile red in the solution (see "Appl. Phys. Lett.", Vol. 67, No. 16, page 2281, 1995) was then coated to form a white light-emitting layer having a dry thickness of 0.16 μ m.

Onto the thus formed white light-emitting layer, magnesium and silver were co-evaporated stripewise and cross-wise with respect to the ITO electrode (anode) to thereby form an Mg/Ag electrode having a thickness of 0.2 μ m and an Mg/Ag molar ratio of 10/1. Onto the Mg/Ag electrode, silver was then singly evaporated to a thickness of 0.2 μ m to form a back electrode (cathode). A d.c. voltage was then applied across the thus prepared EL device for every pixel to cause emission of white light, which then passes through the color filter to give an RGB full color display.

In accordance with the present invention, a color filter layer is formed by using a silver halide color light-sensitive layer on a transparent substrate. Subsequently, a transparent electrode is provided on the color filter layer. A polymer compound is incorporated in an organic compound layer to be provided between the transparent electrode and a back electrode. This arrangement allows most of the production steps to be effected in a coating process. Thus, a full color display comprising an EL device can be efficiently produced at a low cost.

While the invention has been described in detail and with reference to specific examples thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

Claims

1. An electroluminescence device comprising a transparent substrate having thereon at least:

a color filter layer;
a transparent electrode;
at least one organic compound layer including a light-emitting layer; and
a back electrode, in this order,
wherein said color filter layer has red, green and blue pixel patterns formed by a process which comprises:

applying a coating solution of a silver halide photographic layer onto said transparent substrate to form a photographic material;
patternwise exposing said silver halide color photographic material to light; and then
subjecting the exposed silver halide color photographic material to color development.

2. The electroluminescence device according to claim 1, further comprising a water-impermeable protective layer provided interposed between said color filter layer and said transparent electrode.

3. The electroluminescence device according to claim 1 or 2, wherein said organic compound layer comprises at least one layer containing a polymer compound.
- 5 4. The electroluminescence device according to any one of claims 1 to 3, wherein said transparent substrate comprises a flexible plastic.
5. The electroluminescence device according to claim 1, wherein said silver halide color photographic material comprises at least three color light-sensitive layers having color sensitivities different from one another.
- 10 6. The electroluminescence device according to claim 1, wherein said color filter layer further has a black matrix.
7. The electroluminescence device according to claim 1, wherein said at least one organic compound layer comprises a white light-emitting layer and at least one of a hole-transporting layer and an electron-transporting layer.
- 15 8. The electroluminescence device according to claim 1, wherein said light-emitting layer comprises a plurality of emitting materials molecularly dispersed in a polymer.
9. The electroluminescence device according to claim 1, wherein said at least one organic compound layer contains at least one light-emitting polymer material.
- 20 10. A process for producing an electroluminescence device comprising a transparent substrate having thereon at least: a color filter layer having red, green and blue pixel patterns; a transparent electrode; at least one organic layer; and a back electrode, which process comprises pixel pattern formation comprising:
25 applying a coating solution of a silver halide photographic layer onto a transparent substrate to form a photographic material;
 patternwise exposing said silver halide color photographic material to light; and then
 subjecting the exposed silver halide color photographic material to color development, to thereby form said pixel patterns on said transparent substrate.
- 30
- 35
- 40
- 45
- 50
- 55

Fig. 1

